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(54) **TURBINE FOR AN EXHAUST GAS TURBOCHARGER**

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See application file for complete search history.

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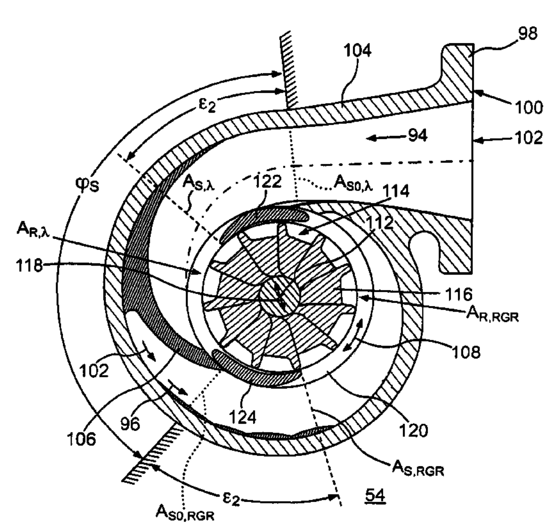
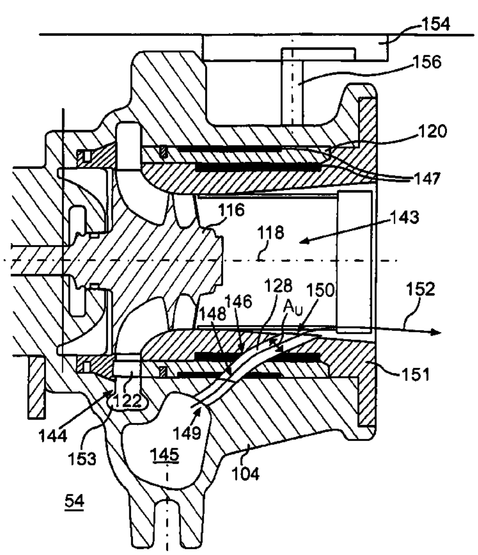
(57) **ABSTRACT**

In a turbine for an exhaust gas turbocharger of an internal combustion engine having a housing part with accommodation space including a turbine wheel and at least one spiral channel via which exhaust gas of the internal combustion engine may flow. The spiral channel has an outlet cross-section via which the turbine wheel accommodated in the accommodation space may be acted on by the exhaust gas, and has at least one blocking member, which is connected to an adjusting part so as to be movable hereby in the peripheral direction of the accommodation space for adjusting the outlet cross-section (A_R, $A_{R\lambda}$, $A_{R,RGR}$). A bypass duct is provided, via which exhaust gas can bypass the turbine wheel and whose flow cross-section is also adjustable by the blocking member moved the adjusting part.

6 Claims, 5 Drawing Sheets





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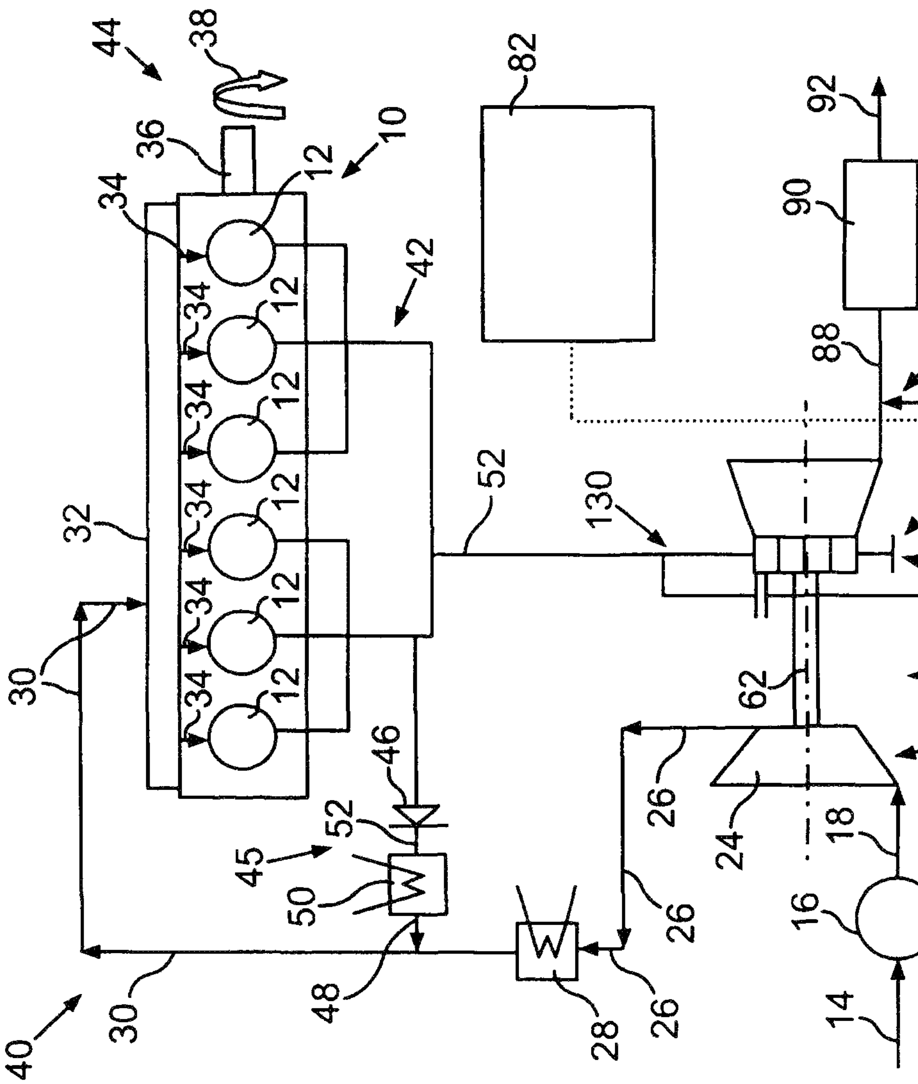
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Fig. 1

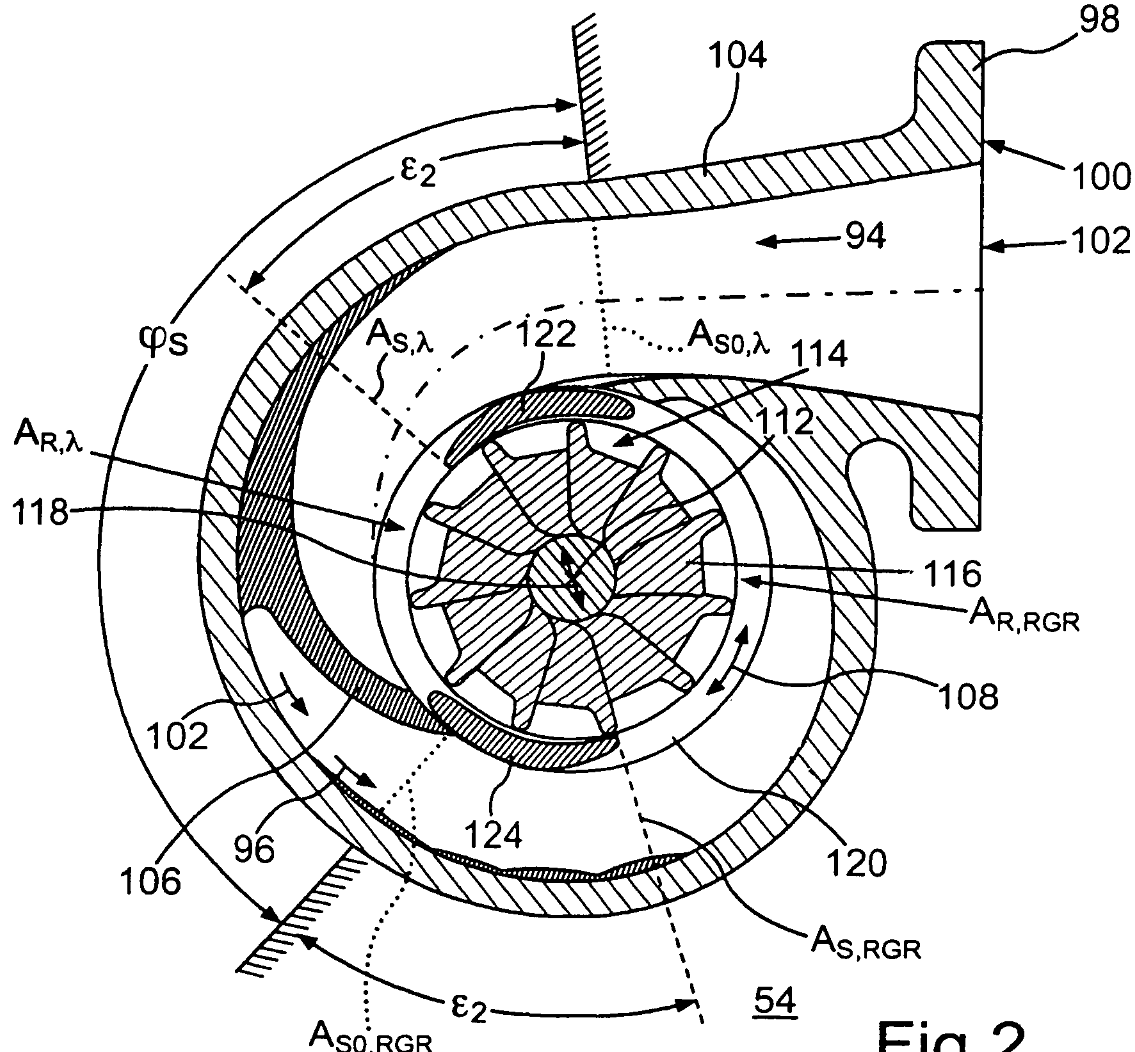
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Fig.2

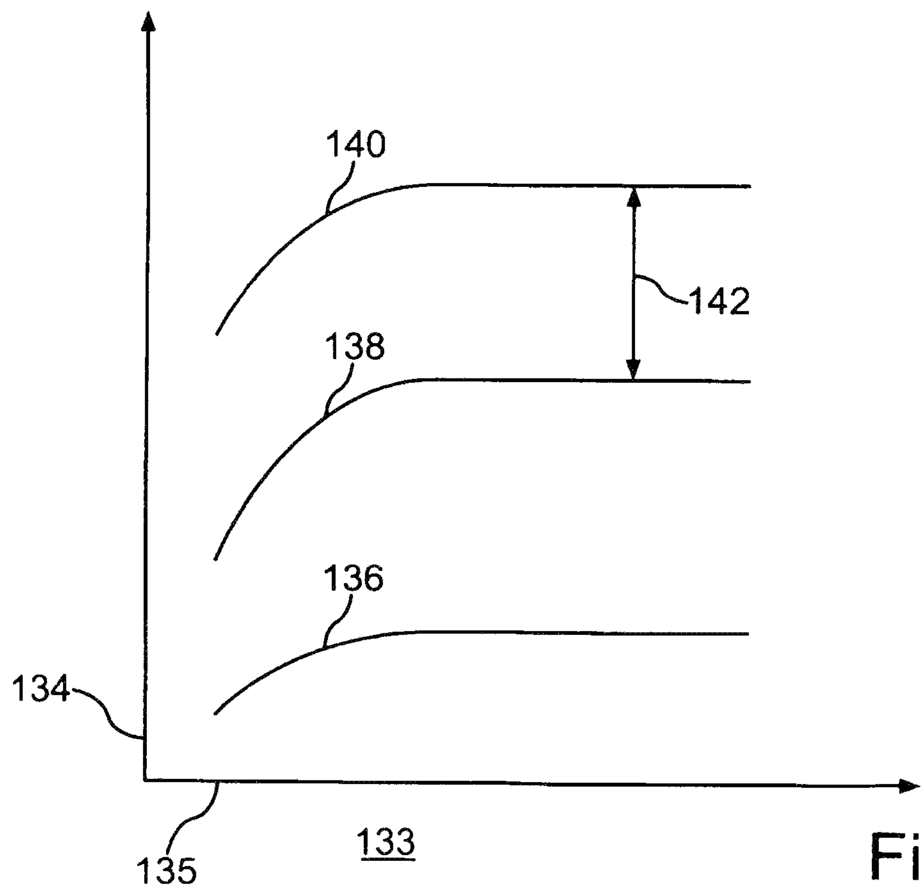

Fig.3

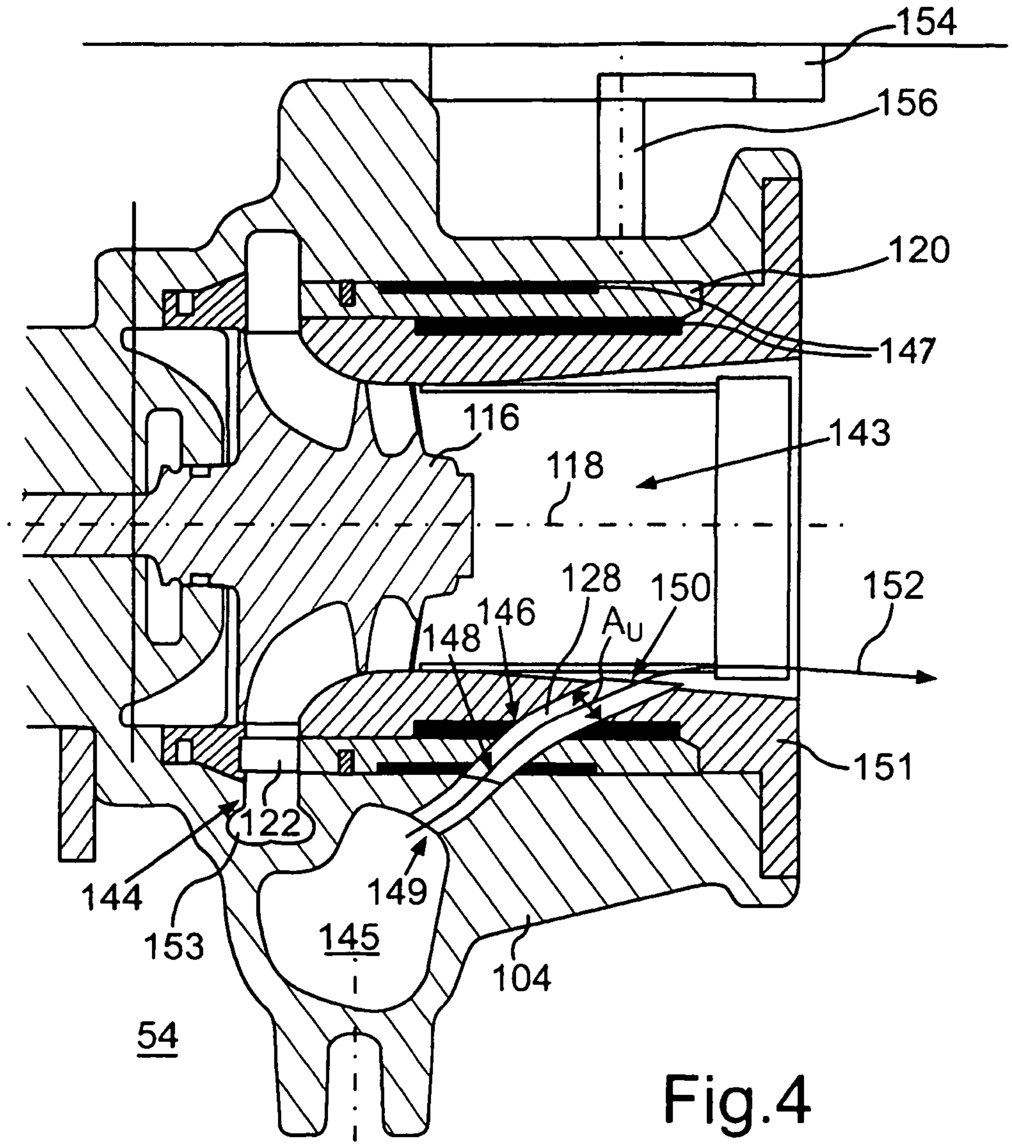

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Fig.4

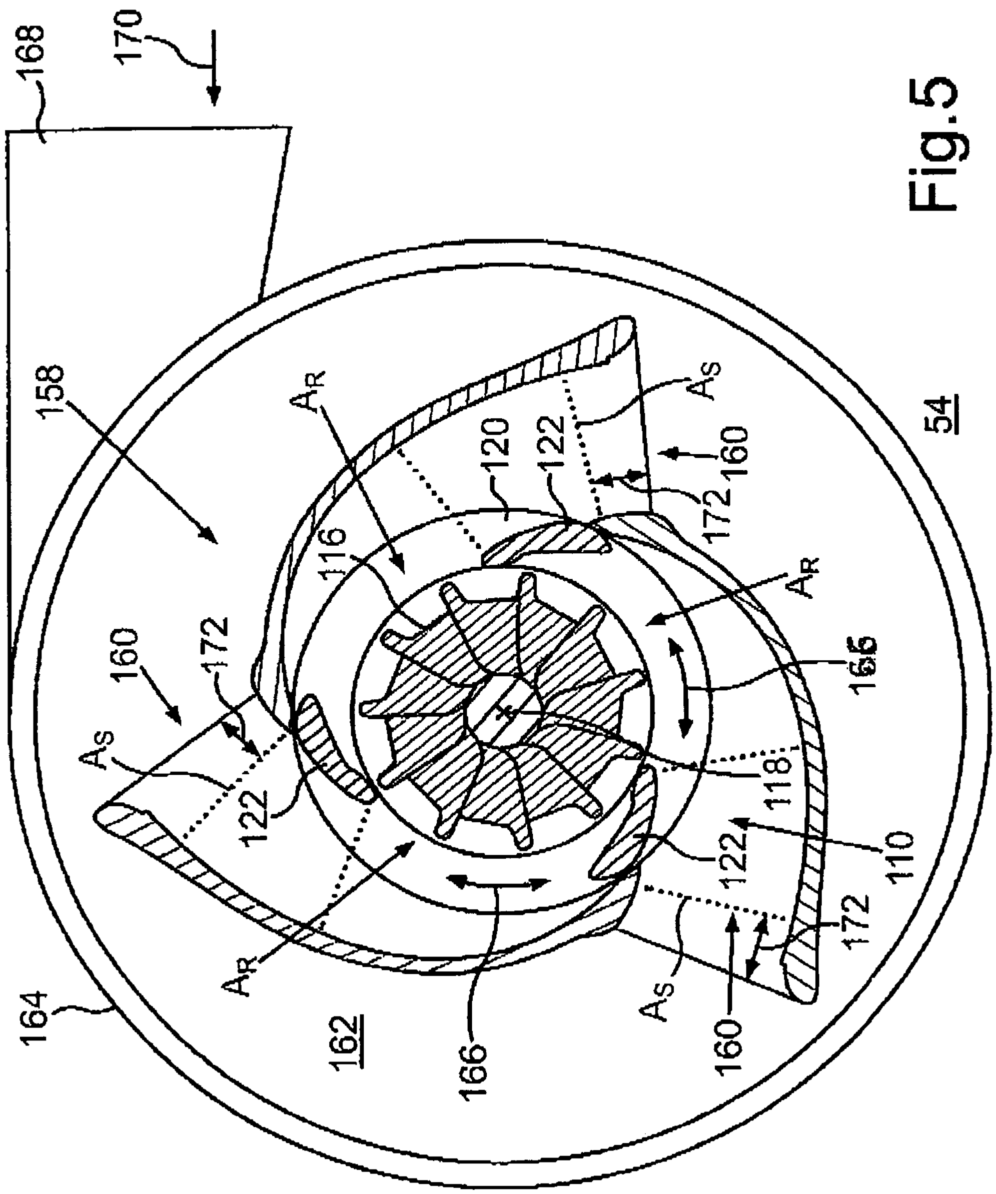
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Fig.5

TURBINE FOR AN EXHAUST GAS TURBOCHARGER

This is a Continuation-In-Part application of International patent application PCT/EP2011/005662 filed Nov. 11, 2011 and claiming the priority of German patent application 10 2010 053 951.1 filed Dec. 9, 2010.

BACKGROUND OF THE INVENTION

The invention relates to a turbine for an exhaust gas turbocharger for an internal combustion engine with a turbine housing including a turbine wheel and having a spiral exhaust gas admission channel with an adjustable blocking member.

DE 25 39 711 A1 discloses a spiral casing for turbomachines, in particular in an exhaust gas turbocharger, having an adjustable cross section, at least in parts, at least one tongue being provided which is slidingly guided against the radially inner wall of the spiral casing and displaceable next to this wall in the peripheral direction.

DE 10 2008 039 085 A1 discloses an internal combustion engine for a motor vehicle having an exhaust gas turbocharger which includes a compressor in an intake tract of the internal combustion engine and a turbine in an exhaust tract of the internal combustion engine. The turbine has a turbine housing which includes a spiral channel, coupled to an exhaust gas line of the exhaust tract, and a turbine wheel which is situated within an accommodation space in the turbine housing and which, for driving a compressor wheel of the compressor and is connected to the turbine wheel in a rotationally fixed manner via a shaft, may be acted on by exhaust gas from the internal combustion engine which is guidable through the spiral channel. The turbine includes an adjusting device by means of which a spiral inlet cross section of the spiral channel as well as a nozzle cross section of the spiral channel are jointly adjustable with respect to the accommodation space.

Since exhaust gas turbochargers represent a mass-produced product manufactured in ever-growing quantities in the serial production of internal combustion engines, it is desirable to provide an exhaust gas turbocharger which allows operation of an associated internal combustion engine which is efficient, i.e., low in fuel consumption and low in emissions.

It is therefore the principal object of the present invention to provide a turbine for an exhaust gas turbocharger which has high operational reliability and provides for efficient operation of an internal combustion engine associated with the turbine.

SUMMARY OF THE INVENTION

In a turbine for an exhaust gas turbocharger of an internal combustion engine having a housing part with accommodation space including a turbine wheel and at least one spiral channel via which exhaust gas of the internal combustion engine may flow. The spiral channel has an outlet cross-section via which the turbine wheel accommodated in the accommodation space may be acted on by the exhaust gas, and has at least one blocking member, which is connected to an adjusting part so as to be movable hereby in the peripheral direction of the accommodation space for adjusting the outlet cross-section (A_R, $A_{R\lambda}$, $A_{R,RGR}$). A bypass duct is provided, via which exhaust gas can bypass the turbine wheel and whose flow cross-section is also adjustable by the blocking member moved the adjusting part.

This means that for adjusting the flow cross section, the blocking member is moved by moving the adjusting part which is connected thereto. In one position of the adjusting part or in a plurality of positions, the flow cross section of the bypass duct is, for example, at least essentially fluidly blocked so that exhaust gas from the spiral channel is not able to bypass the turbine wheel via the bypass duct.

Beginning at one position of the adjusting part, the adjusting part opens up the flow cross section of the bypass duct at least in parts, so that at least a portion of the exhaust gas flowing through the spiral channel is able to bypass the turbine wheel via the bypass duct without acting on and driving the turbine wheel. The turbine wheel is thus bypassed by at least a portion of the exhaust gas from the spiral channel. This is accompanied by a very high mass flow capacity of the turbine.

The power obtainable from turbines of exhaust gas turbochargers is limited by the maximum mass flow capacity of the turbine. In other words, the mass flow with which the exhaust gas flows through the turbine and is able to drive the turbine or the turbine wheel is limited by the maximum mass flow capacity of the turbine. And so is the engine power output. Since the mass flow capacity of the turbine according to the invention is particularly high due to opening up the bypass duct by means of the adjusting part, the turbine according to the invention may be used even at very high mass flows of the exhaust gas, allowing efficient and effective operation of the internal combustion engine.

Due to the adjustability of the flow cross section, the turbine according to the invention has a very high achievable throughput range, so that it is adaptable to a plurality of different operating points of the internal combustion engine and thus allows operation of the internal combustion engine which is efficient, i.e., low in fuel consumption and low in emissions. In addition, due to the adjustability of the outlet cross section, the turbine according to the invention is adaptable to a plurality of different operating points of the internal combustion engine, so that the turbine is able to operate in many different operating points in an efficiency-optimized manner, which likewise benefits the operation of the internal combustion engine with low fuel consumption and low emissions. The turbine according to the invention has efficiency characteristics that are favorable for the operation of the internal combustion engine with low fuel consumption and low emissions, which, in particular due to the adjustability of the flow cross section of the bypass duct in a particularly large operating range, in particular at least essentially over the entire characteristic map, has a positive effect on the internal combustion engine.

In the turbine according to the invention, the flow cross section of the bypass duct is, for example, at least essentially fluidly blockable by means of the adjusting part. In other words, the cross section is then reduced at least essentially to zero, so that exhaust gas is not able to flow through the bypass duct. In addition, the flow cross section may be opened up with respect to the exhaust gas by means of the adjusting part, so that some exhaust gas can flow through the bypass duct while bypassing the turbine wheel during high-load engine operation.

In one advantageous embodiment of the invention, the flow cross section in one position of the adjusting part is at least essentially fluidly blocked, and in another position of the adjusting part is opened up to the maximum extent. In addition, intermediate positions of the adjusting part are settable in which the flow cross section is smaller than the maximum openable flow cross section and larger than the fluid blocking. The adjusting part is advantageously adjustable between these positions in a continuous and/or stepless manner, so that the flow cross section, and thus the quantity of the exhaust gas flowing through the bypass duct, is efficiently adaptable, as needed, to a plurality of different operating points of the turbine and of the internal combustion engine.

Increasingly stringent emission limits, in particular for nitrogen oxides and particulate emissions, have significantly influenced the supercharging of internal combustion engines by means of an exhaust gas turbocharger. This results in high demands on the charge pressure provided by the exhaust gas turbocharger due to high exhaust gas recirculation (EGR) rates to be achieved in medium to full load ranges of the internal combustion engine. This requires provision of a turbine having small geometric dimensions and size for such an exhaust gas turbocharger. High required turbine power is achieved by increasing the backing-up capacity or by reducing the mass flow capacity of the turbine in cooperation with the internal combustion engine.

In addition, an inlet pressure level of the turbine may be increased by the counter pressure generated by exhaust gas purification device, in particular a particle filter, situated in the flow direction of the exhaust gas, downstream from the turbine, which requires further reduction in the dimensions and size of the turbine. This is accompanied by the problem that such a reduction in the turbine generally means impaired efficiency of the turbine. However, this is necessary in order to meet power requirements of a compressor side of the exhaust gas turbocharger in order to provide a desired air-exhaust gas supply, and thus to provide a desired torque or a desired power, as well as low emissions of the internal combustion engine.

The turbine according to the invention now allows small dimensions and size of the turbine, and thus, provision of a desired back-up behavior, which allows high EGR rates. In other words, a particularly large quantity of exhaust gas may be recirculated from an exhaust gas side of the internal combustion engine to an intake air side thereof, and admixed to the air drawn in by the internal combustion engine, thus keeping the emissions, in particular nitrogen oxides and particulate emissions of the internal combustion engine low.

Furthermore, the described high power requirements on the compressor side of the exhaust gas turbocharger may be met by the turbine, since the turbine allows, for example, a inlet charging operation of its associated internal combustion engine. In addition, the turbine according to the invention has a high mass flow capacity and a high throughput range.

In particular in passenger vehicles, the internal combustion engine, and thus the turbine, has a pronounced non-steady state behavior which is to be influenced by a variable back-up capacity of the turbine, in order to achieve an acceptable driving behavior. This plays an important role in particular in internal combustion engines that are designed according to the so-called downsizing principle. These types of internal combustion engines have a relatively small displacement, but at the same time, high power and high torque, which are achieved by the intense supercharging by means of an exhaust gas turbocharger.

The turbine according to the invention allows variable and adaptable adjustment of the back-up behavior, and thus influencing of the non-steady state behavior, in particular due to the adjustability of the outlet cross section, so that the turbine according to the invention is also usable in internal combustion engines for passenger vehicles as well as in internal combustion engines for utility vehicles, and allows operation of the internal combustion engine which is efficient and thus low in fuel consumption and low in emissions, including low CO_2 emissions.

The turbine according to the invention has the further advantages that it has very good efficiency due in particular to the adjustability of the outlet cross section. In addition, this adjustability is achieved by the blocking member using relatively simple means and therefore in an uncomplicated manner as the turbine according to the invention has only a small number of parts, low costs, and a low weight. Furthermore, the turbine according to the invention has only small installation space requirements, which helps solve or avoid packaging problems, in particular in a space-critical area such as an engine compartment. In addition, the turbine according to the invention has high functional reliability, even over a long service life, and also under high loads, in particular pressure and temperature loads.

Despite the very good and very advantageous backing-up capacity of the turbine, in particular due to the adjustability of the outlet cross section and due to its small dimensions, the turbine according to the invention has a high throughput range with a very high mass flow capacity. An appropriate efficiency characteristic is achieved even with customary displacement travel lengths actuators for adjusting the outlet cross section. Thus, the turbine according to the invention, which is also referred to as a tongue diverter turbine since the blocking member may have a tongue-shaped design, may have a throughput range quotient of greater than 3, greater than 4 or, in particular for spark ignition engines, greater than 5 with the simplest geometric specifications. The throughput range quotient is given by the quotient

$$\frac{\phi_{max}}{\phi_{min}},$$

where ϕ_{max} refers to the maximum possible throughput of the turbine and ϕ_{min} refers to the minimum throughput, the turbine according to the invention being adjustable between the maximum throughput ϕ_{max} and the minimum throughput ϕ_{min} due to the adjustability of the outlet cross section and of the flow cross section. This means that the turbine according to the invention may be efficiently operated in a particularly large operating range, especially in connection with spark ignition engines, in which particularly high mass flows of the exhaust gas are present.

In addition, the achievable throughput range and the efficiency characteristic of the turbine according to the invention are also influenced in particular by the configuration and specification of the main dimensions of walls, which are fixed to the housing part and which adjoin the spiral channel at least in parts, and in relation to which the blocking member is movable for adjusting the outlet cross section. In addition, the configuration and the specification of the blocking member, which is situated, for example, in the flow direction of the exhaust gas with respect to the turbine wheel, downstream from the adjusting part, play an important role for the achievable throughput range and the efficiency characteristic of the turbine.

Combining the adjustability of the flow cross section of the bypass duct with the adjustability of the outlet cross section due to the movement of the adjusting part and also of the blocking member has the advantage that just one control element, in particular an actuator, can be used for moving the adjusting part and thus the blocking member, which is accompanied by the adjustment of the outlet cross section, and for adjusting the flow cross section of the bypass duct. This keeps the number of parts, the weight, and the installation space requirements of the turbine according to the invention low. The level of complexity of the control and regulation system for the turbine according to the invention may also thus be kept low.

In one advantageous embodiment of the invention, the adjusting part has at least one passage opening which is movable by moving the adjusting part (which is accompanied by a movement of the blocking member) in at least partial overlap with the bypass duct. If the passage opening in the adjusting part overlaps with the bypass duct or an outlet opening in the bypass duct, the exhaust gas may flow through the bypass duct while bypassing the turbine wheel, and the turbine has a very high mass flow capacity. The passage opening may have a cross section which is at least essentially equal to or greater than a flow cross section of the bypass duct or the outlet opening thereof, so that the passage opening in the adjusting part does not throttle the flow of the exhaust gas through the bypass duct when there is complete overlap with the bypass duct or the outlet opening thereof. This embodiment has the advantage that the adjustability of the flow cross section of the bypass duct is integrated into the adjusting part and is thus achieved in a particularly simple manner, which keeps the installation space requirements and the costs of the turbine low.

It is also thus possible to support the adjusting part particularly well on or in the housing part, thus at least essentially always ensuring easy movement of the adjusting part. This benefits the functional reliability of the turbine according to the invention.

In another advantageous embodiment of the invention, the adjusting part is at least partly, in particular predominantly, in particular completely, accommodated in the housing part that is a turbine housing, for example. The turbine thus has particularly low installation space requirements.

In another particularly advantageous embodiment of the invention, the bypass duct on the one hand is in fluid connection with the spiral channel and/or with a further spiral channel via which exhaust gas is suppliable to the at least one spiral channel, and on the other hand the bypass duct opens into a turbine outlet area of the housing part, downstream from the turbine wheel. In this manner the exhaust gas may be withdrawn particularly well upstream of the turbine wheel and introduced into an exhaust tract downstream from the turbine wheel without the exhaust gas being able to act on and drive the turbine wheel. This also allows bypassing of the turbine wheel without a complicated installation space.

The turbine according to the invention has particularly low installation space requirements, while at the same time achieving the described advantages, if in one advantageous embodiment of the invention the bypass duct is integrated at least partly, in particular predominantly or completely, into the housing part and/or into a further housing part of the turbine. The bypass duct may be provided, for example, by a borehole, a milled-out area, or a recess during production of the housing part by casting. As a result, additional cost- and weight-intensive line parts are not provided, and are not necessary for achieving the very high mass flow capacity and the high throughput range of the turbine according to the invention.

In another advantageous embodiment of the invention, the adjusting part is designed essentially as an adjusting ring. The adjusting part thus has a very low level of complexity and therefore low manufacturing costs, resulting in low costs for the overall turbine.

If the adjusting part for moving the blocking member is movable, in particular about a rotational axis, in the peripheral direction of the accommodation space, the movement of the blocking member and the adjustability of the outlet cross section are made possible in a particularly simple manner. For such a simple movement, there is in particular little risk of the adjusting part jamming, or of undesirably high friction or some other malfunction occurring, which benefits the very good functional reliability of the turbine.

To avoid an undesirable release of exhaust gas from the housing part to the environment, for example, at least one sealing element is advantageously situated between the adjusting part and the housing part and/or between the adjusting part and a further housing part of the turbine. Thus, at least essentially all of the exhaust gas flowing through the turbine may be guided through the turbine outlet and led to an exhaust gas aftertreatment device, situated downstream from the turbine in an exhaust tract of the internal combustion engine, which cleans the exhaust gas before it is ultimately released to the environment.

Further advantages, features, and particulars of the invention will become more readily apparent from the following description of preferred exemplary embodiments with reference to the accompanying drawings. The features and feature combinations mentioned above in the description, as well as the features and feature combinations mentioned below in the description of the figures and/or shown in the figures alone, are usable not only in the particular stated combination, but also in other combinations or alone without departing from the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a diagram of an internal combustion engine which is supercharged by means of an exhaust gas turbocharger, which includes a tongue diverter multi-segment turbine having a bypass duct via which a turbine wheel of the tongue diverter multi-segment turbine may be bypassed;

FIG. **2** shows a schematic cross-sectional view of the tongue diverter multi-segment turbine according to FIG. **1**;

FIG. **3** shows three different curves of the throughput parameter of the tongue diverter multi-segment turbine according to the preceding figures;

FIG. **4** shows a section of a schematic longitudinal view of another embodiment of the tongue diverter multi-segment turbine according to the preceding figures; and

FIG. **5** shows a schematic cross-sectional view of another embodiment of the tongue diverter multi-segment turbine according to FIG. **2**.

DESCRIPTION OF PARTICULAR EMBODIMENTS OF THE INVENTION

FIG. **1** shows an internal combustion engine **10** which has six cylinders **12**. During operation of the internal combustion engine **10**, the internal combustion engine draws in air according to a directional arrow **14**. The air is filtered by an air filter **16** and flows further according to a directional arrow **18** into a compressor **20** of a turbocharger **22** associated with the internal combustion engine **10**. The air is compressed by the compressor **20** by means of a compressor wheel **24**, whereby the air is also heated. For cooling the air that is compressed and heated in this way, the air flows further according to directional arrows **26** to a charge air cooler **28**, and further according to directional arrows **30** to an inlet manifold **32**, via which it is supplied to the cylinders **12** according to directional arrows **34**. The drawn-in and compressed air is acted on by fuel and combusted in the cylinders **12**, resulting in rotation of a crankshaft **36** of the internal combustion engine **10** according to a directional arrow **38**.

The compressor **20** situated on an air side **40** of the internal combustion engine **10** is used to provide a desired air supply to the internal combustion engine **10** for providing a desired level of power or torque of the internal combustion engine **10**.

The internal combustion engine **10** may thus be designed with a small displacement and small dimensions, which is accompanied by low weight, high specific power, low fuel consumption, and therefore low CO_2 emissions.

Exhaust gas from the internal combustion engine **10** resulting from combustion in the cylinders **12** is initially directed, via exhaust gas piping **42** on an exhaust gas side **44** of the internal combustion engine, to an exhaust gas recirculation device **45**, by means of which exhaust gas from the internal combustion engine **10** is recirculated from the exhaust gas side **44** to the air side **40**. For this purpose, the exhaust gas recirculation device **45** includes an exhaust gas recirculation valve **46**, by means of which a specified quantity of exhaust gas to be recirculated is adjustable, which is coordinated with a current operating point of the internal combustion engine **10**. The exhaust gas flows to an exhaust gas recirculation cooler **50** according to a directional arrow **52**, by means of which the exhaust gas is cooled before it is supplied to the air drawn in by the internal combustion engine **10** according to a directional arrow **48**. This action on the drawn-in air by the recirculated exhaust gas results in less emissions, in particular nitrogen oxides and particulate emissions, from the internal combustion engine **10**, which thus has not only low fuel consumption and high power, but also low emissions.

The exhaust gas of the internal combustion engine is supplied via the exhaust gas piping **42** to a turbine **54** of the exhaust gas turbocharger **22**, which is explained below in conjunction with FIG. **2**. It is also possible to use the turbine **54** illustrated in FIG. **5** as the turbine **54** of the exhaust gas turbocharger **22**. The turbine **54** according to FIG. **5** is likewise explained below. The exhaust gas of the internal combustion engine **10** is led in part to a first spiral channel **94** designed as a partial spiral, and in part to a second spiral channel **96**, likewise designed as a partial spiral. The two determining spiral channels **94** and **96** include adjacently situated connecting flanges **98** and **100** which are sealed in a gas-tight manner with respect to one another. The connecting flange **100** and a supply channel **102** of the spiral channel **96** extend below the spiral channel **94**, essentially in the viewing direction relative to the plane of the drawing, the end of the supply channel **102** being shown, in the plane of the drawing, in front of a spiral inlet cross section $A_{S0,RGR}$ and a housing tongue **106** which is fixed relative to a turbine housing **104** of the turbine **54**.

As is apparent from FIG. **2**, the spiral channels **94** and **96** are situated one behind the other, i.e., connected one behind the other, in the peripheral direction of the turbine wheel, over the periphery thereof, according to a directional arrow **108**. The first spiral channel **94** has an angle of wrap ϕ of approximately 135°, and functions as a so-called EGR spiral that is used to back up the exhaust gas, so that a particularly large quantity of exhaust gas is to be recirculated by means of the exhaust gas recirculation device. The second spiral channel **96**, designed as a so-called λ spiral provides by means of its backing-up capacity for a necessary air-fuel ratio of the internal combustion engine **10**.

To be able to adapt the turbine **54** to a plurality of different operating points of the internal combustion engine, at least essentially over the entire performance graph of the internal combustion engine **10**, in an efficiency-optimized manner, the turbine **54** includes an adjusting device **110** by means of which spiral inlet cross sections $A_{S,\lambda}$, $A_{S,RGR}$ of the spiral channels **94** and **96** are adjustable together with nozzle cross sections $A_{R,\lambda}$, $A_{R,RGR}$ of the spiral channels **94** and **96**, respectively, which are open in the radial direction according to a directional arrow **112** and which are used for an inflow process to an accommodation space **114** inside of which a turbine wheel **116** is accommodated so as to be rotatable about a rotational axis **118**. The adjusting device **110** is controlled or regulated by a regulating device **82**.

The adjusting device **110** has an adjusting ring **120**, which is situated concentrically with respect to the rotational axis **118** of the turbine wheel **116** in the turbine housing **104**, and to which two blocking members **122** and **124** are connected in the area of the nozzle cross sections $A_{R,\lambda}$ and $A_{R,RGR}$, respectively. The blocking members **122** and **124** have an at least essentially tongue-shaped design, and therefore are also referred to as tongues, while the adjusting ring **120** is referred to as a tongue slider. The blocking members **122** and **124**, which in the present case have an airfoil-shaped cross section, may be moved by rotational motion of the adjusting ring **120** according to the directional arrow **108**, and thus in the peripheral direction of the turbine wheel **116** over its periphery, about the rotational axis **118** between a position which reduces the spiral inlet cross sections $A_{S,\lambda}$ and $A_{S,RGR}$ as well as the nozzle cross sections $A_{R,\lambda}$ and $A_{R,RGR}$, and a position which enlarges the spiral inlet cross sections $A_{S,\lambda}$ and $A_{S,RGR}$ as well as the nozzle cross sections $A_{R,\lambda}$ and $A_{R,RGR}$. In the illustration in FIG. **2**, the blocking members **122** and **124** are skewed from a starting position by an angle ϵ_2, so that the spiral inlet cross sections $A_{S,\lambda}$ and $A_{S,RGR}$ and the nozzle cross sections $A_{R,\lambda}$ and $A_{R,RGR}$ are set at a minimum value in each case. FIG. **2** also illustrates the maximum spiral inlet cross sections $A_{S0,\lambda}$ and $A_{S0,RGR}$ in the starting position of the blocking members **122** and **124**, respectively.

Thus, with the aid of the adjusting device **110**, both sides of the turbine, the EGR side and the λ side, are simultaneously regulated or controlled with respect to one another, corresponding to the geometric configuration of the spiral channels **94** and **96** and the blocking members **122** and **124**. A variety of combinations may be provided as a result of the different geometric configuration of the spiral curves over the entire adjustment angle range ϵ of the blocking members **122** and **124**. The sought EGR capability of the turbine **54** together with the sought air mass flow of the compressor **20** for a suitable air-fuel ratio λ for producing a desired operating characteristic of the internal combustion engine **10** with regard to fuel consumption and nitrogen oxides and particulate emissions may thus be set within the adjustment angle range ϵ by means of a simple and inexpensive design. The adjustment angle range ϵ in conjunction with the change in the characteristic spiral inlet cross sections $A_{S,\lambda}$ and $A_{S,RGR}$ allows the effect on the back-up behavior of the exhaust gas of the internal combustion engine **10** and on the swirl generation of the turbine **54**. Thus, since the specific turbine power au is proportional to the peripheral component c1u according to the general formula

$$au \sim c1u \sim 1/A_S,$$

the specific and absolute turbine power may be regulated by influencing the surface area of the spiral inlet cross sections $A_{S,\lambda}$ and $A_{S,RGR}$. The turbine **54** is usable in internal combustion engines for utility vehicles and for passenger vehicles, as well as in internal combustion engines designed as diesel engines, spark ignition engines, or combined combustion engines, such as the internal combustion engine **10**.

As is apparent in particular from FIG. **1**, the turbine **54** also includes a bypass device **126** having at least one bypass duct **128**. The turbine wheel **116** is to be bypassed by at least a portion of the exhaust gas via the bypass duct **128**, so that the exhaust gas does not act on or drive the turbine wheel **116**. For this purpose, the bypass device **126** includes a branch point **130** which is situated in the flow direction of the exhaust gas, upstream from the turbine wheel **116**. The bypass device **126** also includes an inlet point **132** at which the exhaust gas bypassing the turbine wheel **116** is reintroduced into the exhaust gas piping **42**. The inlet point **132** is situated in the flow direction of the exhaust gas, upstream of the exhaust gas aftertreatment device **90**, so that the exhaust gas bypassing the turbine wheel **116** is cleaned by the exhaust gas aftertreatment device **90** before it is released to the environment according to a directional arrow **92**.

The quantity of the exhaust gas bypassing the turbine wheel **116** via the bypass duct **128** is now adjustable by means of the adjusting ring **120**. The rotation of the adjusting ring **120** about the rotational axis **118** according to the directional arrow **108** not only causes a movement, in particular a displacement, of the blocking members **122** and **124** about the rotational axis **118** according to the directional arrow **108**, but also brings about the adjustment of a flow cross section A_U (FIG. **4**) of the bypass duct **128** through which exhaust gas which bypasses the turbine wheel **116** may flow.

It may be provided that at a wall of the adjusting ring **120** in a subarea of the adjustment angle range ϵ, the adjusting ring **120** reduces the flow cross section A_U of the bypass duct **128** at least essentially to zero, and thus at least essentially fluidly blocks the flow cross section, so that exhaust gas is not able to flow through the bypass duct **128**. As the result of moving the adjusting ring **120** in the adjustment angle range ϵ in one direction, beginning at a certain position of the adjusting ring **120** the adjusting ring **120** opens up the flow cross section A_U of the bypass duct **128** at least in parts, so that exhaust gas is able to flow through the bypass duct **128**. If the adjusting ring **120** is moved further in this direction, the flow cross section of the bypass duct **128** is successively enlarged and further opened up, accompanied by a successively larger quantity of exhaust gas that is able to flow through the bypass duct **128** in order to bypass the turbine wheel **116**.

It may be provided that the adjusting ring **120** is moved in this direction in the adjustment angle range ϵ until the adjusting ring is rotated or moved into an end position of the adjustment angle range in which the flow cross section A_U of the bypass duct **128** is opened up to a maximum. Likewise, it may be provided that at the maximum adjustment of the flow cross section A_U, and thus at a maximum opening up of the bypass duct **128**, the adjusting ring **120** is in a position from which it may be further moved in the same direction in which it has previously been moved in order to successively enlarge the flow cross section A_U. If this is the case, the flow cross section A_U may, for example, then be held constant at its maximum adjustable value. It is likewise possible that by further movement, in particular rotation, of the adjusting ring **120** the flow cross section A_U is once again successively reduced until the adjusting ring **120** has reached its end position in the adjustment angle range ϵ. In this end position, the flow cross section A_U may then optionally once again be reduced at least essentially to zero.

It is thus possible to adjust the flow cross section A_U of the bypass duct **128** in a variety of ways, and thus to adapt the turbine **54**, in particular its mass flow capacity, to a plurality of different operating points of the internal combustion engine **10**.

As a result of opening up the bypass duct **128**, particularly high mass flows of the exhaust gas of the internal combustion engine **10** may flow through the turbine **54**, in that a portion of the mass flow passes through the turbine wheel **116** and flows through the turbine **54**, and a portion of the exhaust gas flow passes through the turbine **54** via the bypass duct **128**. In other words, providing a very high mass flow capacity of the turbine **54**, and thus providing a very high throughput range, is made possible by opening up the bypass duct **128**. At the same time, blocking the bypass duct **128** allows provision of a very good backing-up capacity of the turbine **54** in order to be able to recirculate a particularly large quantity of exhaust gas.

In addition, the turbine **54** has very good adaptability to a plurality of different operating points, in particular at least essentially over the entire characteristic map of the internal combustion engine **10**, since diverse adjustability of the turbine **54** is provided by the blocking members **122** and **124**. The internal combustion engine **10** may thus be operated very efficiently, and in particular with low fuel consumption and low emissions, which also results in low CO_2 emissions.

FIG. **3** shows a turbine throughput characteristic map **133** of the turbine **54**, with the turbine pressure ratio π_{ts} plotted on the abscissa **135** and the throughput parameter ϕ_T plotted on the ordinate **134**. The turbine throughput characteristic map **133** may be applied to the turbine **54** according to FIG. **5**. A curve **136** of the throughput parameter ϕ_T is plotted in the turbine throughput characteristic map **133**, which results when the blocking members **122** and **124** are set in a minimum position in the adjustment angle range ϵ, in which the nozzle cross sections $A_{R,\lambda}$ and $A_{R,RGR}$ and/or the spiral inlet cross sections $A_{S,\lambda}$ and $A_{S,RGR}$ are set to a minimum value in each case.

Another curve **138** of the throughput parameter ϕ_T is also illustrated, which results when the blocking members **122** and **124** are set by means of the adjusting ring **120** in a maximum position in which the nozzle cross sections $A_{R,\lambda}$ and $A_{R,RGR}$ and/or the spiral inlet cross sections $A_{S,\lambda}$ $A_{S,RGR}$ are set to a maximum value in each case.

A curve **140** of the throughput parameter ϕ_T, illustrated in FIG. **3**, results when, in addition to the maximum position, the bypass duct **128** is in particular opened up to the maximum by means of the adjusting ring **120**. This means that in the turbine throughput characteristic map **133**, the bypass duct **128** is essentially fluidly blocked between the curve **136** and the curve **138**, and in the curves **136** and **138**. If the bypass duct is successively opened up by means of the adjusting ring **120**, starting from the maximum blocking position of the blocking members **122** and **124**, the throughput parameter **4** of the turbine **54** is shifted, for example for an at least essentially constant turbine pressure ratio πT_{ts}, along the ordinate **134** to higher values in the direction of the curve **140**, starting from the curve **138**. If the flow cross section A_U of the bypass duct **128** is reduced, starting from the maximum flow cross section A_U, and the blocking members **122** and **124** are in the maximum position, the throughput parameter ϕ_T is shifted, for at least essentially constant turbine pressure ratio π_{ts}, from the curve **140** in the direction of the curve **138**.

This influencing of the throughput parameter ϕ_T by enlarging or reducing the flow cross section A_U of the bypass duct **128** while the blocking members **122** and **124** are in the maximum position is indicated by a directional arrow **142** in FIG. **3**. An area along the ordinate **134** between the curve **138** (blocking members **122** and **124** in the maximum position, bypass duct **128** fluidly blocked) and the curve **140** (blocking members **122** and **124** in the maximum position, bypass duct **128** opened up to the maximum) is thus referred to as a blow-off area, in which the throughput parameter ϕ_T assumes very high values and may be variably adjusted as a result of increasing or reducing the flow cross section of the bypass duct **128**. The bypassing of the turbine wheel **116** via the bypass duct **128** is referred to as "blow-off."

FIG. **4** shows another embodiment of the turbine **54** together with the turbine housing **104**. The turbine housing **104** has a spiral channel **145**, designed as a supply channel, and at least one further spiral channel **153**. The spiral channel **145** is in fluid connection with the spiral channel **153**, so that the exhaust gas initially flows through the spiral channel **145**, and from there flows into the spiral channel **153**. For example, the turbine housing **104** forms, at least in parts, at least one further spiral channel (not illustrated in FIG. **4**), such as the spiral channel **153**, so that the spiral channel **145** is fluidly divided by the spiral channel **153** and the at least one further spiral channel. The spiral channel **145** then also functions as a collecting channel in which the exhaust gas may collect, and by means of which a back-up charging operation of the internal combustion engine **10** may be provided. It is noted at this point that a back-up charging operation of the internal combustion engine **10** may also be advantageously provided by means of the turbine **54** according to FIG. **2**.

As is apparent from FIG. **4**, the bypass duct **128** has an inlet opening **149** via which the bypass duct is in fluid connection with the spiral channel **145**. The bypass duct **128** also has an outlet opening **150** via which the bypass duct opens into a turbine wheel outlet **143**. The exhaust gas may thus be branched off from the spiral channel **145** upstream of the turbine wheel **116**, and led to the turbine wheel outlet **143** while bypassing the turbine wheel **116**. Thus, the exhaust gas flowing through the bypass duct **128** does not flow through the turbine wheel **116** via a ring nozzle **144**. It is also possible for the bypass duct **128** to be in fluid communication with the spiral channel **153** in order to thus branch off the exhaust gas upstream of the ring nozzle **144**.

As is apparent from FIG. **4**, the adjusting ring **120** has at least one passage opening **146** which is delimited by walls of the adjusting ring **120**. Corresponding to the desired turbine throughput performance graph, such as the throughput characteristic map **133** according to FIG. **3**, for example, beginning at a certain position of the adjusting ring **120** in the adjustment angle range ϵ an overlap results between the passage opening **146** in the adjusting ring **120** and the bypass duct **128** or an outlet opening **148** in the bypass duct **128**, via which the exhaust gas may exit from the bypass duct **128** in the turbine housing **104** and flow through the passage opening **146** in the adjusting ring **120**. A maximum blow-off cross section for a maximum throughput capability of the turbine **54** is provided when the passage opening **146** completely overlaps with the bypass duct **128**. A partial flow of the exhaust gas may thus be branched off from the spiral channel **145**, and in the present case, led over an applicable outer contour piece **151** of the turbine **54** into the turbine wheel outlet **143** according to a directional arrow **152** while bypassing the turbine wheel **116**.

As is further apparent from FIG. **4**, the bypass duct **128** is formed partly in the turbine housing **104** and partly in the outer contour piece **151**, these partial areas being in fluid connection with one another via the passage opening **145** of the adjusting ring **120** when the passage opening **146** of the adjusting ring **120** at least partially overlaps with the corresponding partial areas of the bypass duct **128**.

FIG. **4** also illustrates sealing elements and/or compensators **147**, by means of which the adjusting ring **120** and/or the outer contour piece **151** is/are sealed off, so that exhaust gas is not able to undesirably flow out from the turbine housing **104** to the environment. It is particularly apparent from FIG. **4** that the locking member **122**, and thus also the blocking member **124**, are connected to the adjusting ring **120**, for example designed as one piece, and are movable together with the adjusting ring **120**.

FIG. **4** schematically illustrates an actuator **154** which is connected to the adjusting ring **120** via an actuating part **156**, by means of which the adjusting ring **120** and thus the blocking members **122** and **124** are variably adjustable. Since the adjustment or movement of the adjusting ring **120**, and thus of the blocking members **122** and **124**, is accompanied by the movement of the passage opening **146** relative to the bypass duct **128** or the partial areas thereof, only the actuator **154** is necessary as the sole actuator in order to adjust the spiral inlet cross sections $A_{S,\lambda}$ and $A_{S,RGR}$ and/or the nozzle cross sections $A_{R,\lambda}$, $A_{R,RGR}$, as well as the quantity of the exhaust gas which bypasses the turbine wheel **116** and flows through the bypass duct **128**.

The turbine **54** according to FIG. **5** is designed as a single-flow, so-called tongue diverter multi-segment turbine. The turbine includes a first housing part **158** which has three spiral channels **160** through which exhaust gas of the internal combustion engine **10** may flow. The spiral channels **160** each have spiral inlet cross sections A_S and nozzle cross sections A_R. A turbine wheel **116** of the turbine **54** which is rotatable about a rotational axis **118** is accommodated in the housing part **158**.

The exhaust gas of the internal combustion engine **10** now enters into the spiral channels **160** via the respective spiral inlet cross sections A_S and reaches the turbine wheel **116** via the respective nozzle cross sections A_R, causing the turbine wheel **116** to be driven and rotated by the exhaust gas. The turbine wheel **116** is connected to a shaft of the exhaust gas turbocharger **22**, to which the compressor wheel **24** is also connected in a rotationally fixed manner, as the result of which the compressor wheel **24** is driven by the turbine wheel **116** via the shaft.

The turbine **54** also includes an adjusting device **110**, which in turn includes an adjusting ring **120** which is connected to three blocking members **122** in the form of tongue diverters, each tongue diverter being associated with one of the spiral channels **160**. The adjusting ring **120** is rotatable about the rotational axis **118** of the turbine wheel **116** in the direction of directional arrows **166**, as the result of which the spiral inlet cross sections A_S as well as the nozzle cross sections A_R, uniformly distributed in the peripheral direction of the turbine wheel **116** over the periphery thereof, are adjustable. In other words, the tongue diverters are adjustable between at least one position which narrows or even closes the nozzle cross sections A_R, and at least one position which opens up with respect to the nozzle cross sections A_R, by rotation of the adjusting ring **120**. Variability of the turbine **54** is provided by the adjusting device **110**, as the result of which the turbine **54** is adaptable to different operating points, at least essentially over the entire characteristic map of the internal combustion engine **10**, to provide operation of the internal combustion engine which is efficient and thus low in fuel consumption and low in emissions. The back-up behavior and the throughput behavior of the turbine **54** may be variably set by adjusting the nozzle cross sections A_R.

A pulse charging operation of the internal combustion engine **10** is initially possible due to the spiral channels **160** which form multiple segments of the turbine **54**. To allow a back-up charging operation of the internal combustion engine **10**, the turbine **54** now includes a collection housing **164** by means of which a shared collecting space **162** that is sealed off in a gas-tight manner with respect to the environment by the collection housing **164** and the spiral channels **160** are formed, in which the housing part **158** is accommodated, whereby the collection housing **164** may surround the housing part **158** on the side of a bearing device, and thus on a side facing the compressor wheel **24** and/or on an opposite side, i.e., on the side of a turbine outlet. The collection housing **164** has an inlet channel **168** in which exhaust gas may flow in via the exhaust gas piping **42** according to a directional arrow **170**, and which leads the exhaust gas further into the collecting space **162**. As is apparent from FIG. **5**, the inlet channel

168 tapers in the flow direction of the exhaust gas according to the directional arrow **170**. The exhaust gas introduced into the collecting space **162** via the inlet channel **168** is initially collected in the collecting space **162**, and may flow through the spiral channels **160** to the turbine wheel **116**. The exhaust gas is mixed and collected in the flow direction of the exhaust gas through the exhaust gas piping **42** upstream from the housing part **158**.

Upstream of each of the spiral inlet cross sections A_S, the spiral channels **160** in each case have an at least essentially trumpet-shaped inlet channel area **172** via which the exhaust gas may enter into the spiral channels **160**. The turbine **54** has a high level of variability, as the result of which different back-up behaviors, and thus different EGR rates, may be provided. Likewise, this allows provision of a certain air supply to the internal combustion engine **10** to meet high power and torque requirements. In addition, the turbine **54** has only a small number of parts, accompanied by low costs and a high level of operational reliability.

In principle, it is also possible to provide double-flow turbines analogously to the embodiment of the turbine **54** according to FIG. **5**, in which case a further housing part having at least two spiral channels, for example in the form of the housing part **158**, is situated along the rotational axis **118** of the turbine wheel **116** next to the housing part **158**, and is accommodated in a further accommodation space formed by a further housing part according to the collection housing **164**, according to the accommodation space **166**. Thus, the collecting spaces are then situated in parallel and separated from one another in a gas-tight manner. In this case two housing parts **158** connected in parallel are provided, each of which has a certain back-up effect and brings about a certain pulse charging of the two collecting spaces, which are gas-tight with respect to one another, when the cylinder groups of the cylinders **12** of the internal combustion engine **10** are separated, for example by means of an elbow part, so that, with an adjusting device according to the adjusting device **110** on both sides and a corresponding tongue diverter, a variable, quasi-double-flow pulse turbine is provided which may also involve asymmetrical back-up behavior, depending on the application.

The adjusting device **110** of the turbine **54** is controlled or regulated by the regulating device **82** of the internal combustion engine **10**, which adjusts the adjusting device in order to adapt the turbine **54** to an operating point of the internal combustion engine **10** present at that moment.

The turbine **54** according to FIG. **5** also includes the above-described bypass device **126** having at least one bypass duct **128**, the quantity of the exhaust gas bypassing the turbine wheel **116** via the bypass duct **128** being adjustable by means of the adjusting ring **120**. The rotation of the adjusting ring **120** about the rotational axis **118** according to the directional arrows **162**, similarly to that previously described, not only causes movement, in particular displacement, of the tongue diverters about the rotational axis **118**, but also brings about the adjustment of the flow cross section A_U (FIG. **4**) of the bypass duct **128**, through which the exhaust gas which bypasses the turbine wheel **116** may flow.

What is claimed is:

1. A turbine (**54**) for an exhaust gas turbocharger (**22**) of an internal combustion engine (**10**), comprising:

a housing part (**104**) having an accommodation space (**114**) including a turbine wheel (**116**) and at least one spiral channel (**94**, **96**) for conducting exhaust gas of the internal combustion engine (**10**) to the turbine wheel (**116**), the at least one spiral channel (**94**, **96**) having an outlet cross section (A_R, $A_{R,\lambda}$ $A_{R,RGR}$) for admitting exhaust gas to the turbine wheel (**116**) which is accommodated in the accommodation space (**114**) and acted on by the exhaust gas supplied via the spiral channel (**94**, **96**), and

an adjusting ring (**120**) rotatably supported and accommodated in the housing part (**104**) with at least one blocking member (**122**, **124**) connected to the adjusting ring (**120**) for movement therewith in a peripheral direction (**108**) of the accommodation space (**114**) for adjusting the outlet cross section (A_R, $A_{R,\lambda}$ $A_{R,RGR}$) of the at least one spiral channel (**94**, **96**) and at least one bypass channel (**128**) extending from the at least one spiral channel through a radial opening (**148**) in the adjusting ring (**120**) to a turbine outlet area (**143**) for permitting exhaust gas to bypass the turbine wheel (**116**), the bypass channel (**128**) having a flow cross section (Au) which is also adjustable by rotation of the adjusting ring (**120**) for controlling the exhaust gas flow bypassing the turbine wheel accommodation space (**114**).

2. The turbine (**54**) according to claim **1**, wherein the bypass channel (**128**) has at least one flow passage (**146**) with a flow cross-section which is adjustable by movement of the adjusting ring (**120**) into an overlapping position with the by-pass channel (**128**).

3. The turbine (**54**) according to claim **1**, wherein the bypass channel (**128**) is in fluid communication with at least one of the spiral channel (**94**, **96**) and a further spiral channel (**102**) via which exhaust gas is supplied to the at least one spiral channel (**94**, **96**), and the bypass duct opens into a turbine outlet area (**143**) of the housing pert (**104**) downstream from the turbine wheel (**116**).

4. The turbine (**54**) according to claim **1**, wherein the adjusting ring (**120**) is movable so as to move the blocking member (**122**, **124**) in the peripheral direction (**108**) of the accommodation space (**114**).

5. The turbine (**54**) according to claim **1**, wherein at least one sealing element (**147**) is disposed between the adjusting ring (**120**) and at least one of an outer housing part (**104**) end an inner housing part (**151**) of the turbine (**54**).

6. The turbine (**54**) according to claim **5**, wherein the bypass duct (**128**) is integrated at least partly into the outer and inner housing parts (**104**, **151**) of the turbine (**54**).

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